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Indian Standard

METHOD OF TESTING OIL-FIRED ROTARY DRYERS FOR HOT MIX ASPHALT AND BITUMINOUS MACADAM PLANTS

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

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Indian Standard

METHOD OF TESTING OIL-FIRED ROTARY DRYERS FOR HOT MIX ASPHALT AND BITUMINOUS MACADAM PLANTS

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Indian Standard

METHOD OF TESTING OIL-FIRED ROTARY DRYERS FOR HOT MIX ASPHALT AND BITUMINOUS MACADAM PLANTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 2 December 1969, after the draft finalized by the Construction Plant and Machinery Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 The output of a hot mix asphalt plant or a bituminous macadam plant is often determined by the output of its dryer under certain defined conditions. A need has, therefore, been felt to formulate a standard laying down an accepted basis for measuring the performance of the dryer unit under standardized conditions.

0.2.1 This standard provides a method of testing oil-fired rotary dryers of both continuous and batch types under conditions of composition and temperature agreed to between the parties concerned.

0.2.2 When the user does not lay down particular conditions, the recommended test conditions given in Appendix A may be used to cover the production of dense asphaltic concrete and bituminous macadam. These recommendations also form a basis upon which a manufacturer can state the output of oil-fired rotary dryers.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by basing the standard on B.S. 2096 : 1954 'Method of testing oil-fired rotary dryers for use in asphalt and coated macadam plant', published by the British Standards Institution.

0.4 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard lays down the method for testing oil-fired rotary aggregate dryers of both continuous and batch types, and for reporting the results as given in Appendix B.

*Rules for rounding off numerical values (*revised*).

1.1.1 Recommended test conditions corresponding to the requirements in the manufacture of dense asphaltic concrete and bituminous macadam are also included for use when special test conditions are not laid down, and as a basis upon which manufacturers may declare the output of dryers.

2. GENERAL

2.1 Conditions of Test — Before starting the test the feed of the dryer shall be adjusted to the rated output of the plant and the following conditions of test shall be approved:

a) Type of aggregate to be used,
b) Grading of aggregate,
c) Moisture content in aggregate,
d) Temperature at discharge, and
e) Moisture content in aggregate after drying.

2.1.1 Where special test conditions are not laid down the recommended conditions of test given in Appendix A may be adopted for dryers to be used in the manufacture of rolled asphalt, coated macadam or fine cold asphalt.

2.2 Measurements Required — The following measurements shall be made:

a) Output of aggregate in tonnes per hour,
b) Moisture content before and after drying,
c) Temperature before and after drying,
d) Grading of the aggregate before and after drying, and
e) Fuel consumption in litres per hour and in litres per tonne of aggregate output.

NOTE — The temperature and humidity of the air shall be recorded and an indication given of the speed of the wind.

2.3 Duration of Test — The test period shall be at least 30 minutes. Immediately before the beginning of the test period the dryer shall be run under test conditions for at least 15 minutes, or for such longer time as may be required for stable conditions to be obtained. No variation in conditions shall be made during the period of the test except minor variations (made either manually or automatically) in burner settings to control the temperature.

2.4 Consistency of Aggregate Feed — Means shall be provided to maintain a constant composition and constant rate of feed throughout the test period. The ratio of material passing and retained on an 2·36-mm IS Sieve should be accurately controlled. A constant feed shall be maintained until the last test results have been recorded.

2.4.1 In testing batch dryers the time cycle shall be constant throughout the period of test.

3. TEST PROCEDURE

3.1 Output

3.1.1 The output shall normally be measured at the outlet of the dryer. Where practicable the entire quantity of aggregate dried during the test period shall be discharged as directly as possible into tared vehicles and weighed on an approved weighbridge.

3.1.2 When the test is carried out in the course of normal production or on large continuous dryers, where it is not convenient to weigh the whole output, at least six measurements shall be made, taking the discharge for short periods only, at regular intervals. A tared container should be moved into position to catch the whole flow, or the flow diverted to such a container, for a period which can be accurately timed by a stop watch (for example, 10 to 30 sec according to the capacity of the dryer being tested). The rate of flow in tonnes per hour shall be calculated from the weight of the aggregate in the container.

3.2 Determination of Moisture Content

3.2.1 At least six samples of the aggregate shall be taken at approximately even intervals throughout the test period from both the feed and the discharge ends of the dryer. Where possible, quantities of about 25 kg shall be taken by catching the whole flow in a container inserted into the stream of material. Each of these batches shall be reduced on a sample splitter or ' quartered ' to give a final sample of about 4·5 kg which shall be put into a suitable previously weighed container, for subsequent determination of the moisture content. Where possible, the sample and container shall be weighed immediately to obtain the weight of the sample and its moisture. Care shall be taken to minimize the loss of moisture, particularly from warm material, during the sampling procedure. If immediate weighing is not possible, then an air-tight container shall be used, such as a leverlid tin, and this container and its contents shall be weighed before unsealing. A balance capable of weighing up to 7 kg readable and accurate to 1·0 g shall be used.

3.2.2 The sample should be thoroughly dried either in a well-ventilated oven at 105°-110°C for 24 hours, or by heating over a burner in an open tray, with constant stirring, for 30 minutes after all visible evidences of moisture have disappeared. This method of drying should be repeated on the first sample to ensure that no further loss of weight occurs.

3.2.3 The moisture content of the sample is the difference between the initial and final dried weight expressed as a percentage of the final weight.

3.2.4 If the system of feeding the dryer is such that the above method of sampling would not give reasonably representative samples of mixed constituents at the feed end, then separate sets of samples shall be taken from each constituent of the feed, their moisture contents measured independently, and the average moisture content calculated from the ratios of the various constituents used in the mixed feed material.

3.2.4.1 This ratio may have to be estimated from the grading as referred to under **3.4.**

3.3 Temperature Measurement

3.3.1 The thermometer used shall preferably be a metallic thermometer having a range appropriate to the temperature of the materials, say 0°-100°C for the feed materials, and 0°-260°C for the discharge, and their thermal capacity should not exceed that of a mercury-in-glass thermometer of about 6 mm diameter.

3.3.2 *Feed Temperature* — When the feed is from open stock piles, two or three readings of input temperature (measured by inserting a thermometer deeply into the heap) will be adequate. Should there be reason to expect variations in feed temperature, for example, when feeding from bulk storage bins of pre-dried material, then samples should be taken by the same method and of the same frequency as given in **3.3.2** for the outlet temperature determination.

3.3.3 *Outlet Temperature*

3.3.3.1 Temperature measurements shall be made on the aggregate, leaving the dryer at regular intervals during the period of the test, so that at least six results are obtained during the period of the test. The samples shall be taken by inserting a lagged container into the stream of aggregate, leaving the dryer so as to catch the whole flow for a period sufficient to collect about 9-13·5 kg of material. A lid shall be placed on the lagged container and the aggregate inside shall be mixed gently at intervals for five minutes to allow the temperature of the different particle sizes to even out; the temperature shall then be determined. A can (of diameter 4-6 times the maximum size of the aggregate and depth equal to twice the diameter) may be used on asphaltic materials where the sand content is greater than 50 percent.

NOTE—Before taking the first sample, the container should be brought to temperature by taking a few trial samples before the start of the test period.

3.3.3.2 The thermometer used for the discharge temperature should be kept in some of the hot material of each batch till the following batch is ready.

3.4 Grading of Aggregate

3.4.1 During the process of quartering the batches referred to in **3.2**, a sufficient quantity shall be retained from each batch for drying and sieving

in accordance with IS : 460-1962*. The sample dried for determination of moisture content, if of adequate size, may be used for this grading.

3.4.1.1 If two or more constituents of the aggregate are fed in sequence through the same feed hopper, samples taken as described in **3.2** may not be representative of the mixed feed materials. In such cases, accurate sieve analysis of the feed cannot be made. An approximation should be made by taking sets of samples, each set comprising a sample of each constituent of the feed as brought to the feed hopper.

3.4.1.2 These samples should be graded separately and the composite grading obtained by combining the results in the proportions of each constituent used in the feed. If this result is not in reasonable agreement with the grading of the discharged materials, then combinations of different proportions of the constituent gradings should be tried, until ratios are found which give a composite grading as close as possible to that of the discharged materials. The proportions so found shall be taken as those of the feed material for the purposes of estimation of the moisture content in **3.2**.

3.5 Oil Consumption

3.5.1 The total quantity of oil used during the test period shall be measured to an accuracy of $\pm 2{\cdot}5$ percent. Where possible, a small service fuel tank mounted on a scale, or so connected that it can be weighed or measured accurately by dipping at the beginning and end of the test period, should be used, and the quantity of oil burned calculated from the difference in readings.

3.5.2 Alternatively, the oil level in the main tank should be measured at the beginning and end of the period. The duration should be such that the change of level is at least 40 mm and the measurement should be made to an accuracy of $\pm$ 1 mm. If a change of level as indicated is not achieved, a service tank shall be fitted. All other conditions affecting the level shall be the same at the beginning and end of the period. If the tank is of such a shape that the surface area of the oil can be accurately measured, and does not vary appreciably between the two levels, then the quantity can be calculated from the change of level.

3.5.2.1 If the tank shape is irregular, the quantity shall be measured indirectly. When the burners are off, the level shall be restored to the initial position. Oil shall then be drawn off into separate containers, in which it can be measured, until the level in the tank falls to the lower test level. The quantity drawn off shall be taken as the consumption during the test. In some circumstances, it may be more convenient to add a measured quantity of oil to raise the level in the tank from the lower to the higher test level.

3.5.3 The oil consumption shall be expressed in litres per hour, and in litre per tonne of aggregate dried, the type, calorific value and specific gravity of oil used being specified.

*Specification for test sieves (*revised*).

APPENDIX A

(*Clauses* 0.2.2 *and* 2.1.1)

RECOMMENDED CONDITIONS OF TEST (FOR USE WHEN SPECIAL CONDITIONS ARE NOT LAID DOWN)

A-1. RECOMMENDED CONDITIONS OF TEST

A-1.1 When special conditions of test are not laid down, use of the conditions given in Table 1 are recommended to cover the production of rolled asphalt, coated macadam, and fine cold asphalt.

TABLE 1 RECOMMENDED CONDITIONS OF TEST

(*Clause* A-1.1)

Feed:	Dense Asphaltic Concrete			Bituminous Macadam		
a) Type of aggregate	Crushed rock or gravel			Crushed rock or gravel		
b) Grading	IS Sieve Designation	Percentage passing by weight	Tolerance percent	IS Sieve Designation	Percentage passing by weight	Tolerance percent
	20 mm	100	±5	40 mm	100	±5
	12·5 mm	90	±5	25 mm	85	±5
	10 mm	80	±5	20 mm	65	±5
	4·75 mm	60	±5	10 mm	37·5	±5
	2·36 mm	42·5	±2	4·75 mm	20	±5
	600 micron	23·5	±2	2·36 mm	12·5	±2
	300 micron	18	±2	75 micron	2	±2
	150 micron	12	±2			
	75 micron	7	±2			
c) Temperature	Not less than 5°C			Not less than 5°C		
d) Moisture content	5-6 percent by weight (of dry materials)			5-6 percent by weight (of dry materials)		
Discharge:						
a) Temperature	175°-200°C			Damp condition not more than 80°C Wet condition not more than* 110°C		
b) Moisture content	Not more than 0·25 percent by weight (of dry materials)			Not more than 0·25 percent by weight (of dry materials)		

*Should material originally in a wet condition be required to have an outlet temperature less than 110°C, then a cooling unit or other special method would be required.

APPENDIX B

(*Clause* 1.1)

TYPICAL FORM FOR RECORDING RESULTS OF TEST ON OIL-FIRED ROTARY DRYER

Date.....

Dryer by (manufacturer's name).....

Type of dryer (batch or continuous) .....

a) Length of dryer.....

b) Length of flame.....

c) Type of lining.....

Main duty:

Preparation of aggregates for: Dense asphaltic concrete
Bituminous macadam
Special conditions (give details)

Rated output with damp/wet feed.....tonne per hour

Test Conditions:

Air temperature.....°C Humidity.....

Wind conditions (if dryer tested in the open).....

Type of aggregate (trade group).....

Approximate grading of aggregate (to IS :.....or give percentage passing main sieves.....)

Fine aggregate/coarse aggregate ratio (for asphalt dryer).....

If coupled to dust collector, state type.....

Position of burner in use (where alternative positions are available).....

Test Records:

Start of test run.....hours.....min

End of test run.....hours.....min

Approximate time running before start of test.....hours.....min

Duration of test run.....min.....

Feed materials, average temperature.....°C

Time each charge is dryer (batch dryers).....min

Approximate time of passa ge of material (continuous dryers).....min

Angle of inclination to horizontal.....°

Speed of dryer.....rev/min

Feed Materials

Sample No.	1	2	3	4	5	6
Time taken — minimum from start						
Temperature °C						
Moisture content percentage of dry weight						
Grading: Percentage retained/passing IS Sieve:						
40 mm						
25 mm						
20 mm						
12·5 mm						
10 mm						
4·75 mm						
2·36 mm						
600-micron						
300-micron						
150-micron						
75-micron						

Type of thermometer used for feed material.....

Method of sampling and taking temperature.....

Discharged Materials

Sample No.	1	2	3	4	5	6
Time taken — minimum from start						
Temperature °C						
Moisture content percentage of dry weight						
Grading: Percentage retained/passing IS Sieve:						
40 mm						
25 mm						
20 mm						
12·5 mm						
10 mm						
4·75 mm						
2·36 mm						
600-micron						
300-micron						
150-micron						
75-micron						

Type of thermometer used for discharge material.....

Method of sampling and taking temperature.....

Average feed temperature.....°C

Average discharge temperature.....°C

Average rise in temperature.....°C

Average moisture content in feed.....percent

Average moisture content in discharge.....percent

Average reduction in moisture content.....percent

Total output during test run..... tonne.....kg

Method of estimating output.....

Rate per hour.....tonne.....kg

Calorific value of fuel used.....kilocalories/kg (or kilocalories/litre)

Specific gravity of fuel used.....

Fuel burned during test run.....litre

Fuel consumption per hour.....litre

Fuel consumption per tonne of aggregate.....litre

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